SYMBIOSIS AND THE ORIGIN OF EUKARYOTIC MOTILITY

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Our work continues to test the hypothesis of the origin of eukaryotic cell organelles by microbial symbioses. With the widespread acceptance of the serial endosymbiotic theory (SET) of the origin of plastids and mitochondria, we are testing the novel idea of the symbiotic origin of the centrioles and axonemes (i. e., kinetosomes [9(3) + 0]*; undulipodia including cilia, eukaryotic 'flagella' and all [9(2) + 2] organelles; the mitotic spindle, and other eukaryotic microtubular systems) from spirochete bacteria motility symbioses. Intracellular microtubular systems are purported to derive from symbiotic associations between ancestral eukaryotic cells and motile bacteria. We are pursuing four lines of approach to this problem: cloning the gene of a tubulin-like protein we discovered in *Spirocheata bajacaliforniensis*, seeking axoneme proteins in spirochetes by antibody cross-reaction, attempting to cultivate larger, free-living spirochetes and studying in detail spirochetes (e. g., *Cristispira*) symbiotic with marine animals.

The recent discovery of megabase quantities of DNA in the kinetosomes (the structures underlying all undulipodia) of the green alga *Chylamydomonas reinhardtii* by Hall, Ramanis and Luck [Cell (1989) 59:121-132] has brought our still-controversial hypothesis to the fore of a long-standing, newly intensified debate within the cell biology community on the origin of microtubules in eukaryotic cells. While we await confirmation of Hall's *et al.* report on the presence of a third extranuclear genome (complementary to the genomes of plastids and mitochondria), we plan to probe the spirochete genomic DNA with kinetosome-specific DNA probes in hopes of finding homologous sequences. Regardless of the presence or absence of spirochete-kinetosome DNA homologies, the existence of an extranuclear genome within the elemental structure of eukaryotes, i. e., the kinetosome, is strong circumstantial evidence for an autonomous, symbiotic origin for eukaryotic microtubule-based motility systems.

*-The numbers between brackets refer to the arrangement of 24nm microtubules as seen in transverse electron-microscopic section of these structures.